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(19) (CA) **CANADIAN PATENT** (12)

(54) Steel Cable Activated Magnetic Switch

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Canada

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ABSTRACT

An apparatus for detecting the absence of a magnetically permeable metal cable at a cable sensing site on a rotatable winding drum, comprising: at least a portion of the drum adjacent the cable sensing site being of a lower magnetic permeability than that of the cable; a permanent magnet secured to said portion of the drum adjacent the cable sensing site and oriented such that cable wound on the drum at the cable sensing site conducts magnetic flux between the poles of the magnet; a pole piece of high magnetic permeability projecting from a pole of the magnet to a magnetic field sensing position at a surface of the drum; and a stationary magnetic sensor mounted adjacent the drum and positioned to sense the presence of a magnetic field at the magnetic field sensing position.

The present invention relates to cabl winding drums and more particularly to the remote sensing of the presence or absence of cable on a winch drum.

Winches using steel cable are extensively used in various fields, for example in construction and maritime equipment. In the use of such equipment it is often desired to detect the presence or absence of cable on the drum so that, for example, the drum can be stopped before the end of the cable is reached. One method of accomplishing this is to use an electrical switch inside the winch drum which is activated by physical contact with the cable, either directly or through a linkage. With such an arrangement, slip rings are required to provide an electric connection between the switch on the rotating drum and the stationary drum support. Another disadvantage is the presence of moving parts, which may be damaged or could seize if not maintained properly.

The present invention provides an alternative sensing arrangement.

According to the present invention there is provided an apparatus for detecting the absence of a magnetically permeable metal cable at a cable sensing site on a rotatable winding drum, comprising:

at least a portion of the drum adjacent the cable sensing site being of lower magnetic permeability than that of the cable;

a permanent magnet secured to the portion of the drum adjacent the cable sensing site and oriented such that cable wound on the drum at the cable sensing site conducts magnetic flux

between the poles of the magnet;

a pole piece of high magnetic permeability projecting from a pole of the magnet to a magnetic field sensing position at a surface of the drum; and

a stationary magnetic sensor mounted adjacent the drum and positioned to sense the presence of a magnetic field at the magnetic field sensing position.

The cable on the drum acts as a "magnet keeper" or flux conductor, forming a strong magnetic field between the poles of the magnet, so that there is very little magnetic field at the magnetic field sensing position at the end of the pole piece. When the cable is removed from the sensing site, the pole piece extends the effective length of the magnet to the magnetic field sensing position and the field is detected by the magnetic sensor, to indicate that there is no cable at the cable sensing site on the drum.

In the accompanying drawings, which illustrate exemplary embodiments of the present invention:

Figure 1 is a schematic view, partially in section of a winch drum equipped with an embodiment of sensing apparatus according to the present invention. The cable is shown proportionately larger than normal for the purposes of clarity.

Figure 2 is an enlarged sectional view of part A of Figure 1 showing one embodiment of the invention and the magnetic field when cable is wound upon the drum;

Figure 3 is an enlarged sectional view of part A of Figure 1 showing a second embodiment and the magnetic field when cable is absent from part of the drum;

Figure 4 is a part sectional view of the magnet and insert of Figure 2;

Figure 5 is an elevational view of the right-hand end of Figure 4; and

Figure 6 is an elevational view of the left hand end of Figure 4.

Referring to the drawings, and particularly to Figure 1, there is shown a cable winch 10 with a stationary frame 12 carrying a rotating drum 14 with a core 13 and flanges 15.

A cable 16 is wound on the core of drum 14 in plural superimposed layers. The cable will normally be made from steel however any material having a relatively high magnetic permeability will function satisfactorily. To detect the absence of cable 16 from the layer immediately adjacent the core 13, the drum is provided with a sensing apparatus generally designated 18. As shown in the Figure 2 embodiment, the sensing apparatus 18 consists of a permanent magnet 20 fitted within an insert 11 into the drum core 13 adjacent one of its end flanges 15. The magnet is oriented axially of the drum. The insert 11 is made from a material having a lower magnetic permeability than the cable, a suitable material being an aluminum alloy or a suitable plastic. A soft iron pole piece 22 extends from the pole of magnet 20 through the flange 15 and to a magnetic field sensing position 23. The insert 11 can be held within the drum by known mechanical means such as by an interference fit or flange means or the like (not shown). A stationary magnetic sensor 24 is mounted on the winch frame 10 by any known mechanical means (not shown), to detect a magnetic field at the end of pole piece 22 as the pole

piece 22 passes the sensor 24 during rotation of the drum.

Figures 4, 5 and 6 show the insert 11 which is of part-cylindrical form with the magnet 20 and pole piece 22 embedded therein.

Referring to Figure 3, there is shown an embodiment wherein the whole drum is made from a material having a lower magnetic permeability than that of the material of the cable.

As illustrated in Figure 2, when cable 16 is wound on the drum over the cable sensing site between the poles of magnet 20, the cable acts as a flux conductor or "magnet keeper" and conducts magnetic flux between the poles of the magnet 20. The magnetic field at the magnetic field sensing position is low and below the level at which it will be detected by sensor 24. As shown in Figure 3, when the cable is absent from the cable sensing site, the magnetic flux is conducted through the soft iron pole piece 22 to the magnetic field sensing position 23 at the end flange 15 of the drum 14. The magnetic sensor 24 detects this relatively strong magnetic field as the pole piece 22 passes the sensor during rotation of the drum. The output of the sensor is used to generate a signal that may in turn be used to produce a warning for a winch operator that the cable is almost depleted.

The magnetic field sensor may be any one of a number of known devices. For example it may be a magnetic field detector, a Hall Effect sensor or a reed switch.

The illustrated embodiment of the invention shows the magnet embedded in the drum and oriented parallel to its axis. It is to be understood that other arrangements are possible within the scope of the invention, provided the magnet is positioned and

oriented to use the cable at a cable sensing site as a magnet keeper.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An apparatus for detecting the absence of a magnetically permeable metal cable at a cable sensing site on a rotatable winding drum, comprising:

at least a portion of the drum adjacent the cable sensing site being of a lower magnetic permeability than that of the cable;

a permanent magnet secured to said portion of the drum adjacent the cable sensing site and oriented such that cable wound on the drum at the cable sensing site conducts magnetic flux between the poles of the magnet;

a pole piece of high magnetic permeability projecting from a pole of the magnet to a magnetic field sensing position at a surface of the drum; and

a stationary magnetic sensor mounted adjacent the drum and positioned to sense the presence of a magnetic field at the magnetic field sensing position.

2. The apparatus of Claim 1 wherein the portion of the drum adjacent the cable sensing site consists of an insert into which the permanent magnet and the pole piece are embedded.

3. The apparatus according to claim 1, wherein the drum is made from a material of low magnetic permeability.

4. The apparatus according to claim 3, wherein the drum is made from an aluminum alloy.

5. The apparatus according to claim 4, wherein the magnet and the pole piece are fitted within the drum core.

6. The apparatus according to claim 1, wherein the magnet is parallel to the axis of the drum, and the pole piece projects to an end of the drum.

7. The apparatus according to claim 1, wherein the magnetic and pole piece are fitted within the drum core.

8. The apparatus according to claim 1, 5 or 7, wherein the magnetic sensor is a magnetic field detector.

9. The apparatus according to claim 1, 5 or 7, wherein the magnetic sensor is a Hall Effect sensor.

10. The apparatus according to claim 1, 5 or 7, wherein the magnetic sensor is a reed switch.

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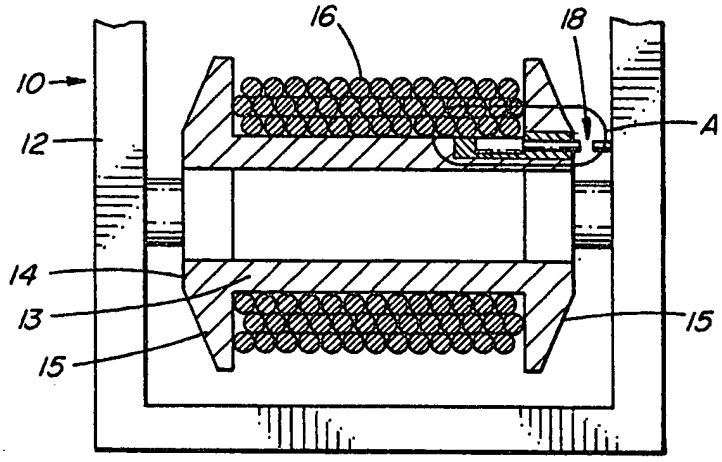

FIG. 1

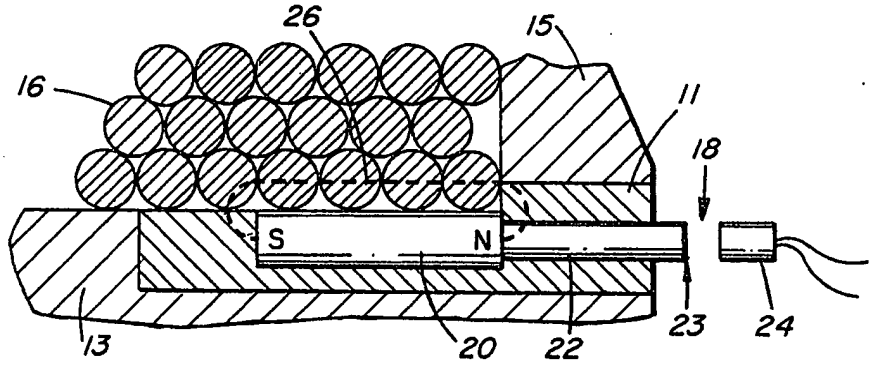

FIG. 2

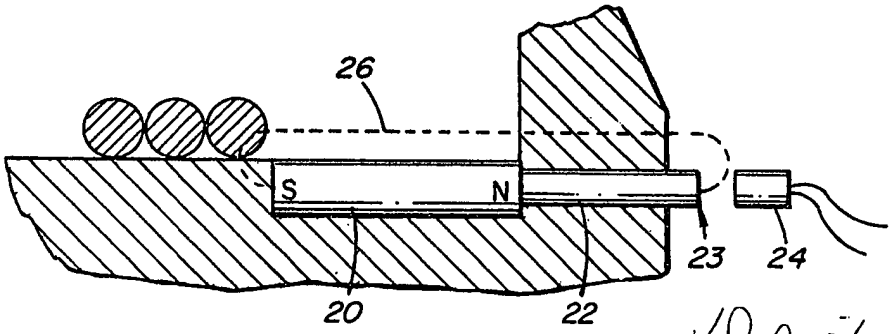

FIG. 3

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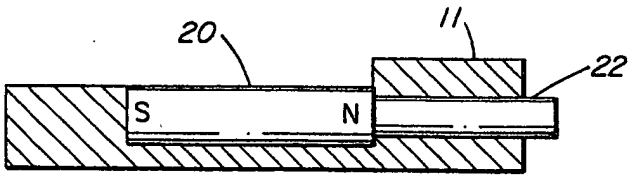

FIG. 4

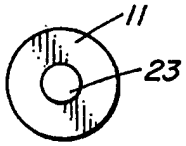

FIG. 5

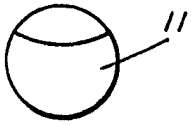

FIG. 6

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